If you are using a printed copy of this procedure, and not the on-screen version, then you MUST make sure the dates at the bottom of the printed copy and the on-screen version match.
The on-screen version of the Collider-Accelerator Department Procedure is the Official Version.
Hard copies of all signed, official, C-A Operating Procedures are kept on file in the C-A ESHQ Training Office, Bldg. 911A.

C-A OPERATIONS PROCEDURES MANUAL

2.5 Operational Safety Limits/Accelerator Safety Envelope for AGS, Booster and Linac

Text Pages 2 through 11

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Approved: _____***Signature on File***_____ _____
Collider-Accelerator Department Chairman Date

E. Lessard

2.5 Operational Safety Limits/Accelerator Safety Envelope for AGS, Booster and Linac

1. **Purpose**

This procedure defines the responsibilities for the Operational Safety Limits (OSLs) for the AGS, Booster and Linac portions of the C-A complex including associated experimental areas in order to provide a safe and healthy workplace, protect the environment, and comply with applicable SBMS requirements.

Separate ASE parameters are provided for the Tandem Van De Graaff (OPM 2.5.1), for the Collider for routine operations (OPM 2.5.2) and for the NASA Space Radiation Laboratory (NSRL) for routine operations (OPM 2.5.3). The Operational Safety Limits (OSLs) and the Accelerator Safety Envelope parameters are equivalent safety limits as indicated in 1.1 and 1.2 below. The Department is on schedule to prepare an ASE and update the SAD for AGS, Linac and Booster by 2005; however, until that time, we retain the use of OSLs and the SAR in place of the ASE parameters and the SAD:

1.1 Operational Safety Limits (OSLs) are auditable boundaries of operation, which are not to be exceeded during normal operations to ensure safety. The OSLs define the conditions, safe boundaries and administrative controls to ensure that the Collider-Accelerator complex is operated within the guidelines defined. These OSLs are imposed on ion accelerator operations since there exists the potential to produce conditions that could risk the health and safety of employees, cause substantial damage to facilities and equipment, or damage the environment.

1.2 Accelerator Safety Envelope parameters are a set of physical and administrative conditions based on the ASE approved by DOE that establish the boundaries within which the Collider-Accelerator complex is to be operated in a safe and environmentally sound manner. See DOE Order O 420.2, Accelerator Safety, for additional information.

2. **Responsibilities**

2.1 The Department Chair shall approve all changes to the Operational Safety Limits (OSLs).

2.2 The on-duty Operations Coordinator shall follow OSL-C-A 1.0, 4.0, 5.0, and 6.0. Written confirmation for any deviation must be obtained from the C-A Department Chair, or Associate Chair for ESHQ, or by the Associate Chair for Operations.

2.3 The liaison physicists shall follow the OSL-C-A 1.0 and 2.0, and shall obtain written confirmation for any deviation from the C-A Radiation Safety Committee.

2.4 The Head of the Access Controls Group shall follow the OSL-C-A 3.0, and shall obtain written confirmation for any deviation from the C-A Radiation Safety Committee.

2.5 The Head of the Access Controls Group or designate shall follow OSL-C-A 7.0, and shall obtain written confirmation for any deviation from the C-A Associate Chair for ESHQ.

3. Prerequisites

None

4. Precautions

None

5. Procedure

Operational Safety Limits have been established for:

A. Energy flux of beams of unpolarized protons, polarized protons and heavy ions in the AGS, Booster and/or Linac.

B. Skyshine radiation and activation of ground water.

C. C-A Access Control System.

D. Fire protection prerequisites in the AGS Ring, Booster and Linac.

E. Personnel requirements in the Main Control Room.

F. Target watch personnel requirements for experimental areas.

G. Area Radiation (Chipmunk) monitoring system testing and calibration.

5.1 Energy Flux Operational Safety Limits (**OSL-C-A 1.0**)

I. Persons Responsible: Liaison physicists for Linac, Booster or AGS, Operations Coordinators.

II. Systems requiring limit: The AGS, Booster, Linac, SEB, SBE, and FEB targets.

III. Purpose of limit: to restrict the intensity of radiation fields to on-site areas

IV. Parameters Limited: Energy flux of protons and heavy ions accelerated (GeV-nucleons/hour). Energy flux of protons on targets.

V. Requirements

1. Design Features

The shielding and active interlock circuitry of the Collider-Accelerator Complex are designed and tested to assure that acceptable radiation levels will not be exceeded at the limiting energy fluxes. Liaison physicists are to be familiar with the physical limits of the machine or target for which they are responsible in order to ensure physical limits are below OSLs.

2. Operational Safety Limits

a. The limit for unpolarized protons, polarized protons and heavy ions in the AGS Ring has been set at 1.1×10^{19} GeV-nucleons/hour.

b. The limit for unpolarized protons, polarized protons and heavy ions in the Booster has been set at 5.4×10^{17} GeV-nucleons/hour.

c. The limit for unpolarized protons and polarized protons in the Linac has been set at 9×10^{17} GeV-nucleons/hour.

d. The limits for protons on targets are given in C-A-OPM Temporary Procedure, "Procedure to Limit Flux of Protons on Targets". This procedure is reviewed and approved prior to each running period by the C-A RSC Chair and the C-A Associate Chair for ESHQ.

3. Administrative Controls

The liaison physicist shall document the physical limit of the machine or target for which he/she is responsible and to ensure the physical limit is below the OSL. The liaison physicist must notify the C-A Department Chair prior to initiating changes to machine configuration that cause one to exceed the OSLs.

5.2 Beam Loss Operational Safety Limits (**OSL-C-A 2.0**)

I. Persons Responsible: Liaison physicists for Linac, Booster, AGS and experimental areas.

II. Systems requiring limit: The accelerators and experimental Areas.

III. Purpose of the limit: to constrain radiation and radioactivity produced by the beam.

IV. Parameter Limited: Dose-equivalent per year at defined locations in the Collider-Accelerator Complex. The corresponding number of lost protons per year is listed as current Limiting Conditions of Operation (LCO). These may change as shielding is upgraded and other advances occur but the Operational Safety Limits reflect current DOE orders.

V. Requirements:

1. Design Features:

Shielding in the C-A Complex requires bounding the maximum beam loss at critical locations because of the radiation hazards, including production of radionuclides in ground water. Radiation detectors throughout the complex are monitored and displayed in the MCR.

2. Safety Limits and Current Limiting Conditions of Operation.

OSL	LCO (protons per year p/y)
5 mrem/y at site boundary 25 mrem/y at non-C-A on-site facilities	$7x10^{19}$ p/y at 28 GeV or equivalent lost at A, F or J superperiods in AGS $2.2x10^{19}$ p/y at 1.5 GeV or equivalent stopped at the Booster F6 septum $1.5x10^{20}$ p/y at 1.5 GeV or equivalent stopped at the Booster beam dump (Note: LCO below is more restrictive and is to be used)

5 mrem/y at site boundary 25 mrem/y at non-C-A on-site facilities	8.5×10^{12} mrem-cm^2/y on beam stop top - surfaces (e.g. 1300 mrem/h for 20 weeks on a roof-surface area of 2000 ft^2)
5 DCG of ^{22}Na in ground water	2.5×10^{20} p/y at 28 GeV at target caves that have 1.5 m or equivalent heavy concrete between target and soil 2.9×10^{19} p/y at 1.5 GeV or equivalent stopped at the dump in Booster Alternatively, soil samples may be used to determine potential for exceeding the 5 DCG ^{22}Na OSL.

3. Administrative Controls. The liaison physicist or designate reviews cumulative loss data (if available), beam loss monitor data, periodic activation patterns along the beam lines, and radioactivity concentrations in soil samples or from the ground water monitoring program to assure that the limits are not exceeded, restricting beam intensity and/or beam loss as required.

5.3 High Hazard Access Control System Operational Safety Limits (**OSL-C-A 3.0**)

I. Persons Responsible: The Head of the Access Controls Group shall ensure that the systems in use are tested and are functional. The on-duty Operations Coordinator shall ensure C-A-OPM 4.1, "C-A Complex Access Control Procedures for Primary Beam Enclosure" is followed.

II. Systems requiring limit: Linac, Booster, AGS, transfer lines, primary beam lines and beam caves.

III. Purpose of the limits: To prohibit personnel from entering any area with potential for dose rates greater than 50 rem per hour.

IV. Parameters Limited: Functional capacity of the Access Control System, and Primary Beam Accessibility Matrix, C-A-OPM-ATT 4.1.b.

V. Requirements:

1. Design Features:

The system is designed and tested in an ongoing program to assure that all interlocks are functional, and that reach back components provide additional protection to eliminate all potential sources of beam when the system is activated.

2. Safety Limits:

All portions of the Access Control System that are in use must be 100% functional and tested in accord with Appendix 3A of the BNL RadCon Manual.

3. Administrative Controls:

The Access Control System is installed and maintained by a technical group dedicated to this function alone. The group is appropriately trained and all procedures are prescribed in C-A OPMs. The Radiation Safety Committee controls and checks the functional aspects of all circuitry. Stringent prohibitions are enforced against unauthorizied personnel actions that may alter operation of the access controls. Sweep and reset procedures are performed by trained staff members using procedures in Chapter 4 of the OPM. The Primary Beam Accessibility Matrix, C-A-OPM-ATT 4.1.b, is reviewed and authorized by the Radiation Safety Committee.

5.4 Fire Protection Operational Safety Limits in the C-A Accelerators and Experimental Areas (**OSL-C-A 4.0**)

I. Persons Responsible: The on-duty Operations Coordinator, or the C-A ESH Coordinator, shall take appropriate action should either or both the installed fire detection and fire suppression systems are impaired for a specific area in the AGS, Booster, Linac or associated experimental areas and accelerator support buildings. The required actions are described in the operating procedures (C-A OPM 3.24).

II. Systems requiring limit: (1) The installed fire detection and suppression systems in the AGS ring, Booster ring and Linac transport line, including smoke detectors in the AGS HVAC system, and the manual fire alarm stations in the AGS, Booster and Linac. (2) The installed fire detection and suppression systems and the manual fire alarm stations in buildings that provide electrical power supplies and instrumentation for ring and transport line operations.

III. Purpose of the limit: to minimize fire hazard to personnel, equipment and the program.

IV. Parameter Limited: Functional capacity of the required systems.

V. Requirements:

1. Design Features:

The incidence of fire is minimal due to the low flammability of the magnets and cables, the stringent controls on flammable gases and liquids, including liquid hydrogen used in beam line experiments, control of ignition sources and interlocking/over-current protection of equipment that pose ignition potentials. Beam enclosures for extraction into experiments and experiment transport lines and target caves are made of concrete in order to meet shielding requirements, and are nonflammable. Fire spread rating on cables decreases their fuel contributions. Minimization of transient combustibles further reduces the potential size of a fire.

The inaccessible portions of the accelerators during beam operations have fire detection and suppression. The detection includes smoke detectors and heat detectors, with smoke detection the most sensitive for early warning of a fire. Fire suppression is provided automatically by sprinkler system or manually by the BNL Fire Rescue Group that is manned at all times, regardless of the machine status.

During periods of authorized inoperability of all or portions of the fire detection and suppression systems, compensatory actions, including administrative and operating procedure guidance or a fire watch, are used to continue to ensure adequate detection of a fire so the BNL Fire/Rescue Group may be summoned by manual fire alarm, radio or phone.

2. Safety Limits:

a. During periods of beam operation, when access to the primary beam areas at Linac, Booster or AGS is prohibited, the installed fire detection and suppression systems shall be operable.

Exception: Within 2 hours of discovery, the Department Chair or designee, may allow partial or full inoperability of any fire detection and/or suppression system for up to 80 hours with beam operations if the benefit of continuing accelerator operations is judged to outweigh the potential risk of fire damage. Operating procedures (C-A-OPM 3.24) shall specify the compensatory actions to be taken during inoperability.

b. During periods of shutdown, if the facility is to be occupied, the installed fire detection and suppression systems or the manual fire alarm stations, in the occupied areas shall be operable.

Exception: The Operations Coordinator, ESH Coordinator or designee, may allow partial or full inoperability of any fire detection system, occupied areas as long as a Fire Watch is posted who can verbally communicate with the BNL Fire/Rescue Group by radio or phone.

3. Administrative Controls: Maintenance and testing of fire protection and detection systems is described in Facility Use Agreements.

5.5 MCR Personnel Operational Safety Limits (**OSL-C-A 5.0**)

I. Persons Responsible: The on-duty Operations Coordinator shall ensure that the MCR is appropriately staffed during operations.

II. System requiring limit: The AGS, Booster and Linac during running periods.

III. Purpose of the limit: To restrict operation to an adequate number of qualified personnel in the MCR.

IV. Parameters Limited: The minimum number and training of MCR Operators when the accelerators are in operation.

V. Requirements:

1. Design Features:

Not applicable.

2. Safety Limit:

A minimum of 2 qualified operators for Linac only operation, or 1 qualified operator and 1 qualified Operations Coordinator for all other machine operations with particle beam.

3. Administrative Controls:

Operation procedures (see C-A OPM Chapters 1 and 2).

5.6 Target Personnel Operational Safety Limits (**OSL-C-A 6.0**).

I. Persons Responsible: The on-duty Operations Coordinator.

II. System requiring limit: Liquid Hydrogen Targets.

III. Purpose of the limit: To restrict operation to an adequate number of qualified personnel on target watch.

IV. Parameter Limited: The minimum number and training of target watch personnel when liquid hydrogen is in use in the experimental area.

V. Requirements:

1. Design Features:
Not applicable.

2. Safety Limit:
A minimum of 1 qualified Cryogenics Group technician.

3. Administrative Controls:
Operation procedures (C-A-OPMs).

5.7 Chipmunk Monitoring System Calibration and Testing (**OSL C-A 7.0**)

I. Persons Responsible: The Head of the Access Controls Group or his designate shall ensure that all Chipmunk radiation monitors placed in service during Collider-Accelerator operations are calibrated and tested.

II. System requiring limit: The Chipmunk Radiation Monitoring System.

III. Purpose of the limit: To assure that the radiation monitoring system is properly calibrated and tested prior to operations.

IV. Parameter Limited: The calibration status of radiation monitors.

V. Requirements:

1. Design Features: Calibration stickers.

2. Safety Limit: All Chipmunk radiation monitors that are in use must be in calibration and be tested.

3. Administrative Controls: Operations Procedures,

C-A-OPM 8.15.1, "C-A Equipment Calibration Procedure for Chipmunks",
C-A-OPM 8.15.3, "Chipmunk Radiation Monitors",
C-A-OPM-ATT 8.15.3.a "Chipmunk Installation Request Form",
C-A-OPM 8.15.4, "Functional Test of the Chipmunk Computer Interface".

6. Documentation

None

7. References

As listed in Sections 1 through 5 of this OPM.

8. Attachments

None